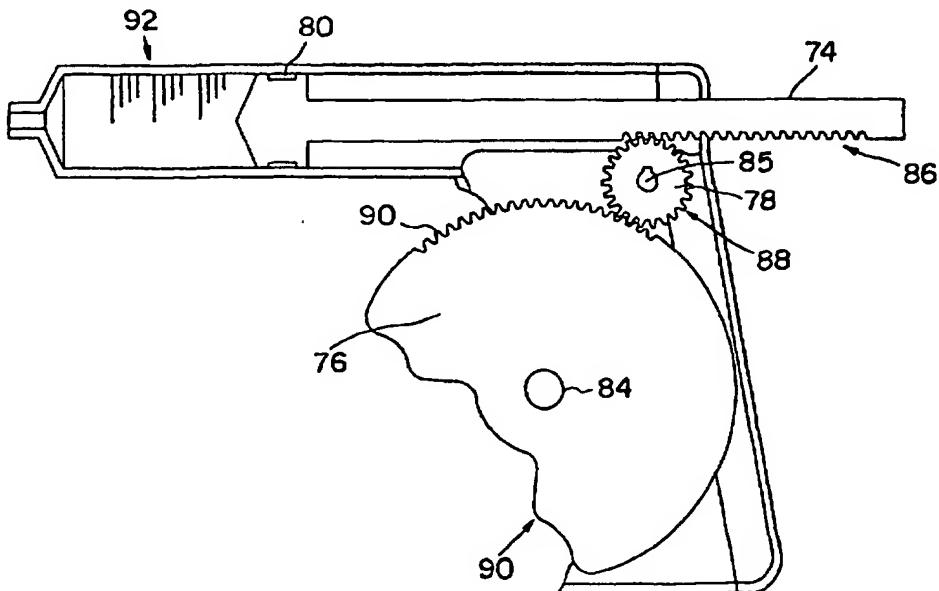


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(54) Title: HIGH PRESSURE SYRINGE



(57) Abstract

A high pressure syringe comprises in combination a barrel (70) having a hand gun-like handle (72), a plunger (74) slidably mounted within the barrel, and a disc trigger (76) rotatably mounted on the handle, said disc trigger having a plurality of teeth (90) on a peripheral edge thereof, for interfacing via an interposed toothed wheel (78) with gear teeth (86) on a stem of the plunger.

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1

HIGH PRESSURE SYRINGE

2 The present invention is directed to syringes. The invention has
3 particular utility for injecting viscous materials into a manifold, needle,
4 catheter or the like; for example, the very viscous dye required to visualize
5 coronary anatomy in diagnosis and treatment of arterial diseases, and will be
6 described in connection with such utility, although other utilities are
7 contemplated.

8 Currently available syringes require the exertion of a tremendous
9 amount of hand pressure, often resulting in suboptimal injections and hand
10 fatigue. Most syringes used for this purpose involve two loops on opposite
11 sides of the syringe for the first and second fingers and a plunger which either
12 fits in the palm of the hand or is operated by the thumb. Such syringes are
13 marketed by NAMIC, MERIT, Statco, Fruend, the ACS division of Eli Lilly
14 and other medical device manufacturers. Recently, cardiovascular
15 innovations introduced a high pressure syringe illustrated in Fig. 1 in which a
16 syringe 30 is mounted in a frame 32 comprising a base 34 and a pivotally
17 mounted lever arm 36 which provides a mechanical advantage for operating
18 the syringe 30.

19 Yet another high pressure syringe is shown in U.S. Patent 5,078,690.
20 Referring to Figs. 2 and 3 which are assembly drawings from U.S. Patent
21 5,078,690, the syringe comprises an outer housing portion generally indicated
22 at 2, and an inner portion generally indicated at 4. The outer portion 2
23 preferably is formed of an optically transparent material, and has a
24 downwardly extending finger grip handle 6 which is shown to be open at the
25 rear 7. The inner housing has a downwardly extending inner handle 8 which
26 fits within the opening 7. The upper part of the outer housing 2 defines an
27 inner cylinder 10 in which a piston 12, carried by the inner housing 4 can fit.
28 Outer housing portion 2 and inner portion 4 each preferably comprise unitary
29 molded parts formed of a medically approved material such as polycarbonate
30 or polypropylene. A resiliently deformable sealing tip 14, formed of a

1 medical grade rubber, elastomer or the like, or an O-ring is carried on the
2 forward end 24 of piston 12 and provides a high pressure seal between the
3 piston 12 and the inner cylinder 10. A fluid feed opening 16 is provided in
4 outer housing 2 to permit egress of the high pressure viscous liquid into a
5 suitably attached catheter, manifold, needle or the like.

6 The catheter or other injection system device is attached with a female
7 coupling known in the trade as a LUER-LOK to the outer housing male
8 LUER-LOK tip 22. An alternative embodiment utilizes a captive and rotatable
9 female threaded fitting with an O-ring seal affixed to the syringe tip 22. Both
10 embodiments incorporate rotatable couplings that are snapped together.

11 The present invention provides an improvement in high pressure
12 syringes. More particularly, in accordance with the present invention, there is
13 provided a hand gun-like shape syringe having a barrel with a handle. A
14 plunger is mounted within the barrel. A disc trigger is rotatably mounted on
15 the handle, and has a plurality of teeth on a peripheral edge thereof for
16 interfacing with gear teeth on a stem of the plunger. In a preferred
17 embodiment, a gear wheel is interposed between the rotatably mounted disc
18 trigger and the stem of the plunger for providing further enhanced
19 mechanical advantage.

20 Other features and advantages of the present invention will be seen
21 from the following detailed description, taken in conjunction with the
22 accompanying drawings, wherein:

23 Figs. 1-3 are side elevational views of prior art high pressure syringe
24 devices;

25 Figs. 4 and 5 are cross-sectional views of a syringe made in a first
26 embodiment of the invention; and

27 Fig. 6 is a side-elevational view; and

28 Figs. 7 - 10 are cross-sectional views of two alternative embodiments of
29 syringes made in accordance with the present invention.

1 Referring to Figs. 4 and 5, the syringe in accordance with a first
2 embodiment of the present invention has three main components, a barrel 40
3 with a handle 42, a slidably mounted plunger 44, and a rotatably mounted
4 disc trigger. In addition to these elements, the syringe also has other
5 necessary or miscellaneous components, such as a seal 50 on the plunger and
6 a disc trigger pivot pin 54. The barrel with handle is similar to other syringe
7 designs such as U.S. Patent No. 5,078,690 that have a hand gun-like shape.
8 The plunger 44 is slidably mounted within the barrel 40, and has gear teeth
9 56 which interface with teeth 58 of the disc trigger 46. The disc trigger 46
10 rotates about pivot pin 54 at its center and is used to move the plunger 44.
11 The disc trigger and plunger work together like a rack-and-pinion gear works.
12 When the upper portion 60 of the disc trigger 46 of the disc trigger is
13 squeezed, it causes the plunger to move backward in the barrel thus filling the
14 syringe with fluid. (See Fig. 4). Conversely, when the lower portion 62 of the
15 disc trigger is squeezed, it causes the plunger to move forward and thus
16 injecting the fluid into the catheter system. (See Fig. 5).

17 An alternative embodiment of syringe in accordance with the present
18 invention is shown in Fig. 6-8.

19 Referring to Figs. 6-8, the syringe includes a barrel 70 with a handle 72,
20 a slibably mounted plunger 74, a rotatably mounted disc trigger 76 and gear
21 wheel 78. In addition to these, the syringe also has other necessary or
22 miscellaneous components, such as a seal 80 on the plunger and pivot pins 84,
23 85. As before, the barrel with handle is similar to other syringe designs such
24 as U.S. Patent No. 5,078,690 that have a hand gun-like shape. The plunger 74
25 is slidably mounted in the barrel, and has gear teeth 86 which interface with
26 teeth 88 of the gear wheel 78. The gear wheel 78 is rotatably mounted and
27 positioned between the plunger 74 and disc trigger 76, and is contained
28 within the handle 72. The disc trigger 76 turns about pivot pin 84 at its center
29 and is used to rotate gear wheel 78 by interface of teeth 90 with teeth 88 of

1 gear wheel 78 which in turn moves the plunger 74. The disc trigger, gear
2 wheel, and plunger all work together like a rack-and-pinion gear works.
3 When the lower portion 90 of the disc trigger 76 of the disc trigger is
4 squeezed, it causes the plunger to move backward in the barrel thus filling the
5 syringe with fluid. (See Fig. 7). Conversely, when the upper portion 92 of the
6 disc trigger is squeezed, it causes the plunger to move forward in the barrel,
7 thus injecting fluid in the barrel into the catheter system. (See Fig. 8).

8 A further alternative embodiment of syringe in accordance with the
9 present invention is shown in Figs. 9 and 10.

10 Referring to Figs. 9 and 10, the syringe includes a barrel 100 with a
11 handle 101, a slidably mounted plunger 102, a rotatably mounted double disc
12 trigger 103 and gear wheel 104. In addition to these, the syringe also has other
13 necessary or miscellaneous components, such as a seal 105 on the plunger and
14 pivot pins 106, 107. As before, the barrel handle is similar to other syringe
15 designs such as U.S. Patent No. 5,078,690 that have a gun-like shape. The
16 plunger 102 is slidably mounted in the barrel, and has gear teeth 108 which
17 interface with teeth 109 of the gear wheel 104. The gear wheel 104 is rotatably
18 mounted and positioned between the plunger 102 and double disc trigger
19 103, and is contained within handle 101. The double disc trigger 103 turns
20 about pivot pin 106 at its center and is used to rotate gear wheel 104 by
21 interface of teeth 110 with teeth 109 of gear wheel 104 which in turn moves
22 the plunger 102. The double disc trigger, gear wheel, and plunger all work
23 together like a rack-and-pinion gear works. When the lower portion 111 of
24 the double disc trigger 103 is squeezed, it causes the plunger to move
25 backward in the barrel thus filling the syringe with fluid. (Fig. 9).
26 Conversely, when the upper portion 112 of the double disc trigger is
27 squeezed, it causes the plunger to move forward in the barrel, thus injecting
28 fluid in the barrel into the catheter system (Fig. 10), i.e. similar to the
29 embodiment shown in Figs. 6-8. In this latter embodiment, the double disc

1 trigger 103 provides additional mechanical advantage over that of the
2 embodiment of Figs. 6-8. As force is applied to the outer disc edge 113 of the
3 double disc trigger, it yields a higher force on the inner disc edge 114. The
4 increase in force is a ratio of the diameters of the edges of the disc. Thus, if an
5 operator can apply X-pounds of force to the outer disc edge, a force of greater
6 than X-pounds will be applied to the inner disc edge and in-turn a force of
7 greater than X-pounds will be applied to the plunger. Finger ring syringes
8 can only produce X-pounds of force on the plunger.

9 The aforementioned syringes have a handle mounted to the barrel that
10 has a gun-like appearance. It is conceived within the present invention that
11 the shape of the handle and barrel could be different. It is possible that the
12 handle and barrel can be aligned to each other as opposed to nearly
13 perpendicular. In this alignment, it is still possible to have the rack-and-
14 pinion gear mechanisms described above in order to control in-and-out
15 movement of the plunger via rotation of the disc trigger. It is also possible to
16 design the trigger in a manner that does not rotate, but still drives a disc with
17 gear teeth and thus controls in-and-out movement of a plunger.

18 The syringe of the present invention comfortably fits in the hand and it
19 uses the natural kinematics and grip strength of the hand. This strength is
20 definitely optimized when filling the syringe. Finger ring syringe designs
21 require spreading the thumb away from the forefinger and middle finger in
22 order to fill the syringe. The design of the present syringe uses a squeezing
23 (or grip) action to fill and empty the syringe. The syringe design also
24 provides mechanical advantage because of the rack-and-pinion gear works,
25 particularly the Figs. 6-10 embodiments.

26 The syringe design of the present invention also has other performance
27 requirements that are expected of syringes for this type of application. They
28 include, but are not limited to the following:

29 • Design that maximizes strength of hand.

- 1 • Disposal and provided sterile.
- 2 • Inexpensive - the barrel and handle may be molded as a one-piece
- 3 unit.
- 4 • Easy to use.
- 5 • Volume of syringe = 15 cc or greater.
- 6 • Minimum pressure threshold of 20 atm without leakage.
- 7 • Force required to fill syringe or inject solution not to exceed force
- 8 requirements of current available syringes
- 9 • Lucent, translucent, or see-through components as needed to
- 10 visualize solutions and/or a suitably marked graduated scale 92.
- 11 • Fast; able to fill or inject syringe fast when needed, for example,
- 12 when priming the manifold, catheter, or tubing.
- 13 • Low tendency for air bubbles, no more than current available
- 14 syringes.
- 15 • Comply with mandatory or voluntary performance standards.
- 16 • All materials meet biocompatibility requirements.
- 17
- 18

CLAIMS

- 1
- 2 1. A high pressure syringe, comprising, in combination:
3 a barrel 70 having a handle 72;
4 a plunger 74 slidably mounted within the barrel; and
5 a disc trigger 76 rotatably mounted on the handle, said disc trigger
6 having a plurality of teeth 90 on a peripheral edge thereof, for interfacing with
7 gear teeth 86 on a stem of the plunger.
- 8 2. A high pressure syringe according to claim 1, wherein said
9 barrel 70 and handle 72 comprise a one-piece molded member having a hand-
10 gun like shape.
- 11 3. A high pressure syringe of claim 1, wherein said plunger 74 is
12 slidably sealed within said barrel.
- 13 4. A high pressure syringe according to claim 1, and further
14 including a rotatably mounted gear wheel 78 interposed between the
15 rotatably mounted disc trigger 76 and the stem of the plunger 74.
- 16 5. A high pressure syringe according to claim 1, wherein said disc
17 trigger 76 comprises a gripping surface of size and shape to accommodate
18 multiple human fingers.
- 19 6. A high pressure syringe according to claim 1, wherein said
20 barrel is lucent or translucent, and includes a graduated scale 92.
- 21 7. A high pressure syringe, comprising a barrel 100, having a
22 handle 101, a plunger 102 slidably mounted within the barrel, a gear wheel
23 104, and a double disc trigger 103 rotatably mounted in the handle, said
24 double disc trigger having a plurality of teeth 110 on a peripheral edge
25 thereof, for interfacing with gear teeth 109 on said gear wheel 104 which in
26 turn interfere with gear teeth 108 on a stem of the plunger; said double disc
27 trigger having a ratio between the two discs of the trigger so that the trigger
28 103, a gear wheel 104, and plunger 102 have an increased mechanical
29 advantage between force input on the trigger and force output on the plunger.

1 8. A high pressure syringe, comprising a barrel 100 having a
2 handle 101, a plunger 102 slidably mounted within the barrel, and a gear train
3 arrangement 108, 109, 110 with triggering feature 103 thereof, so that the gear
4 train controls movement of the plunger through the trigger feature.

5 9. A high pressure syringe according to claim 8, wherein said gear
6 train arrangement 108, 109, 110 affords mechanical advantage between force
7 input on the trigger feature 103 and force output on the plunger 102.

8

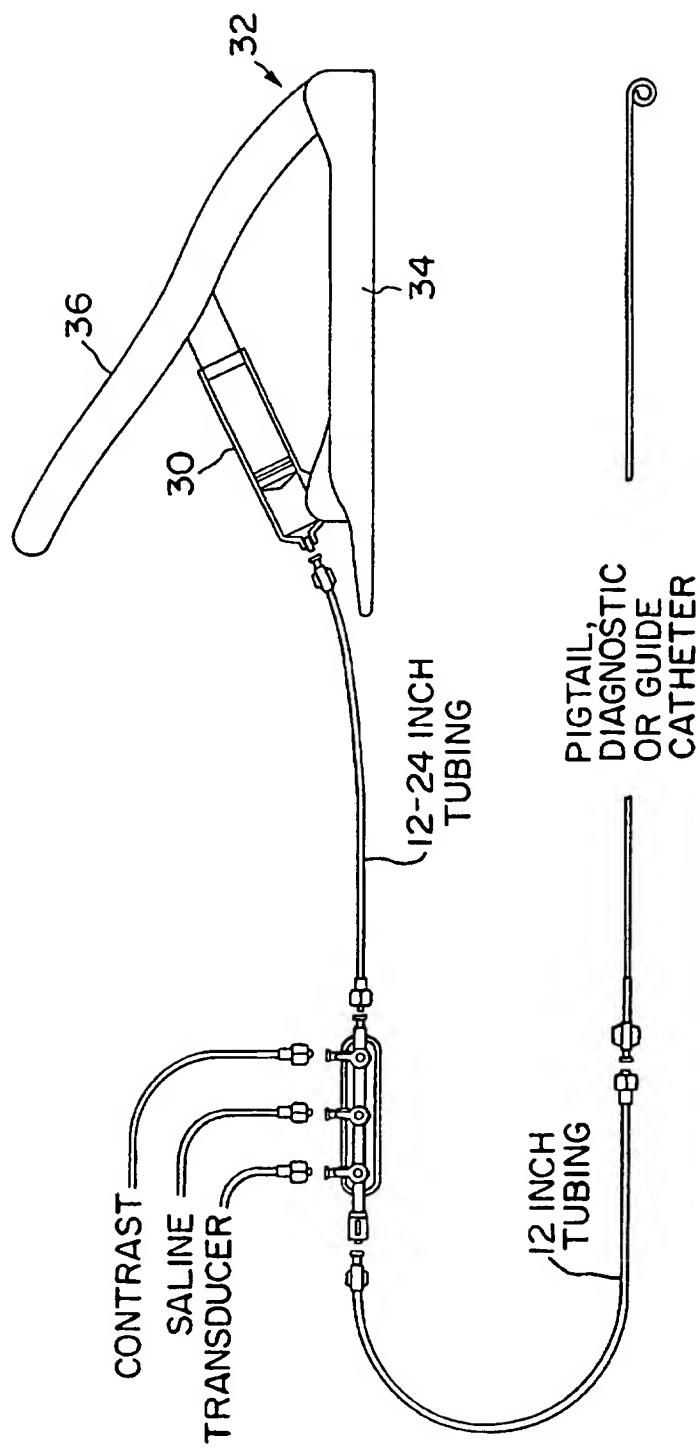


FIG. I
PRIOR ART

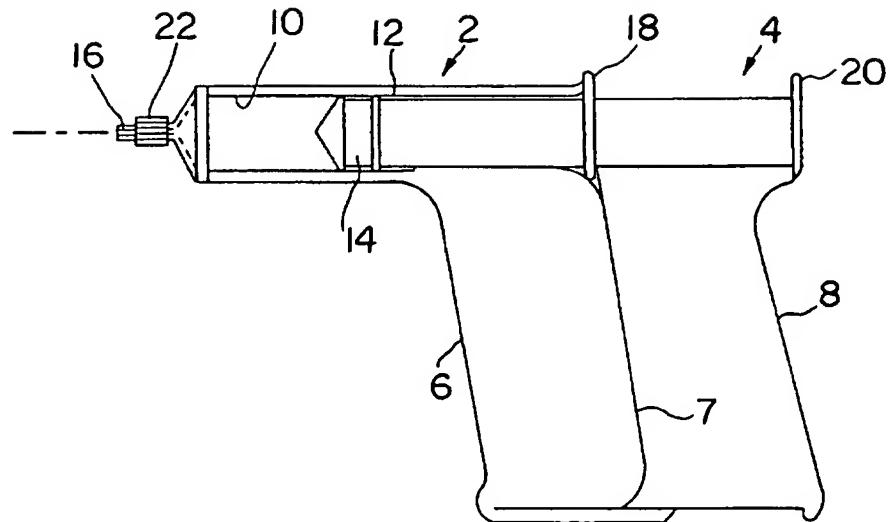


FIG. 2
PRIOR ART

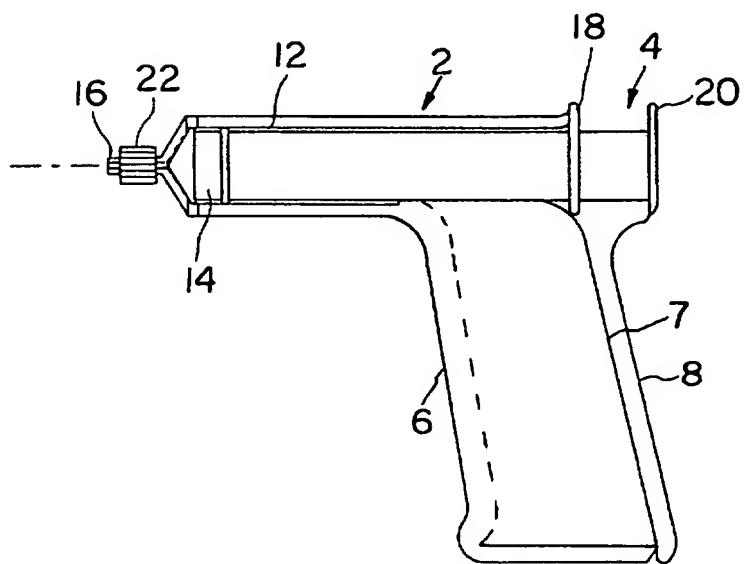


FIG. 3
PRIOR ART

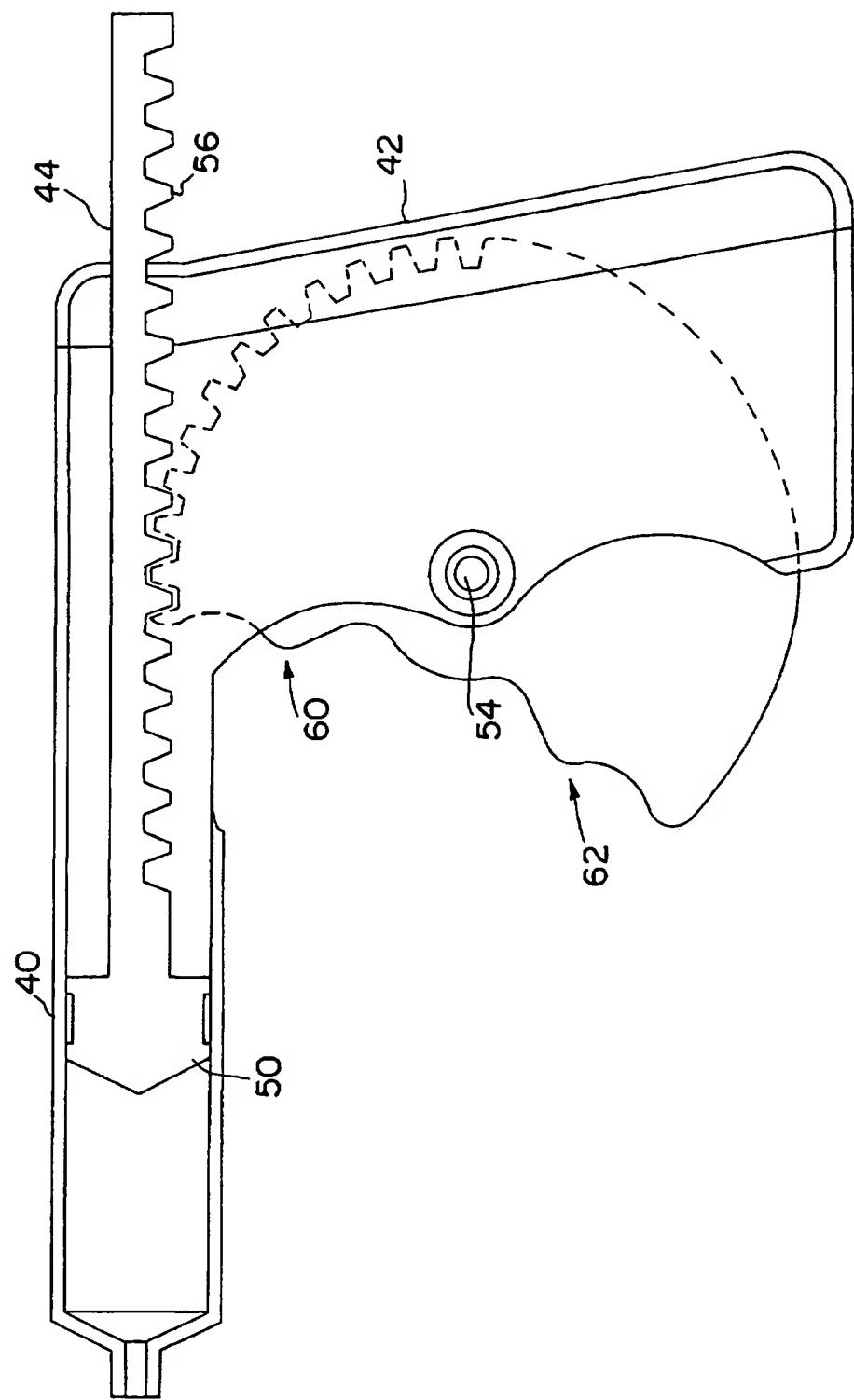
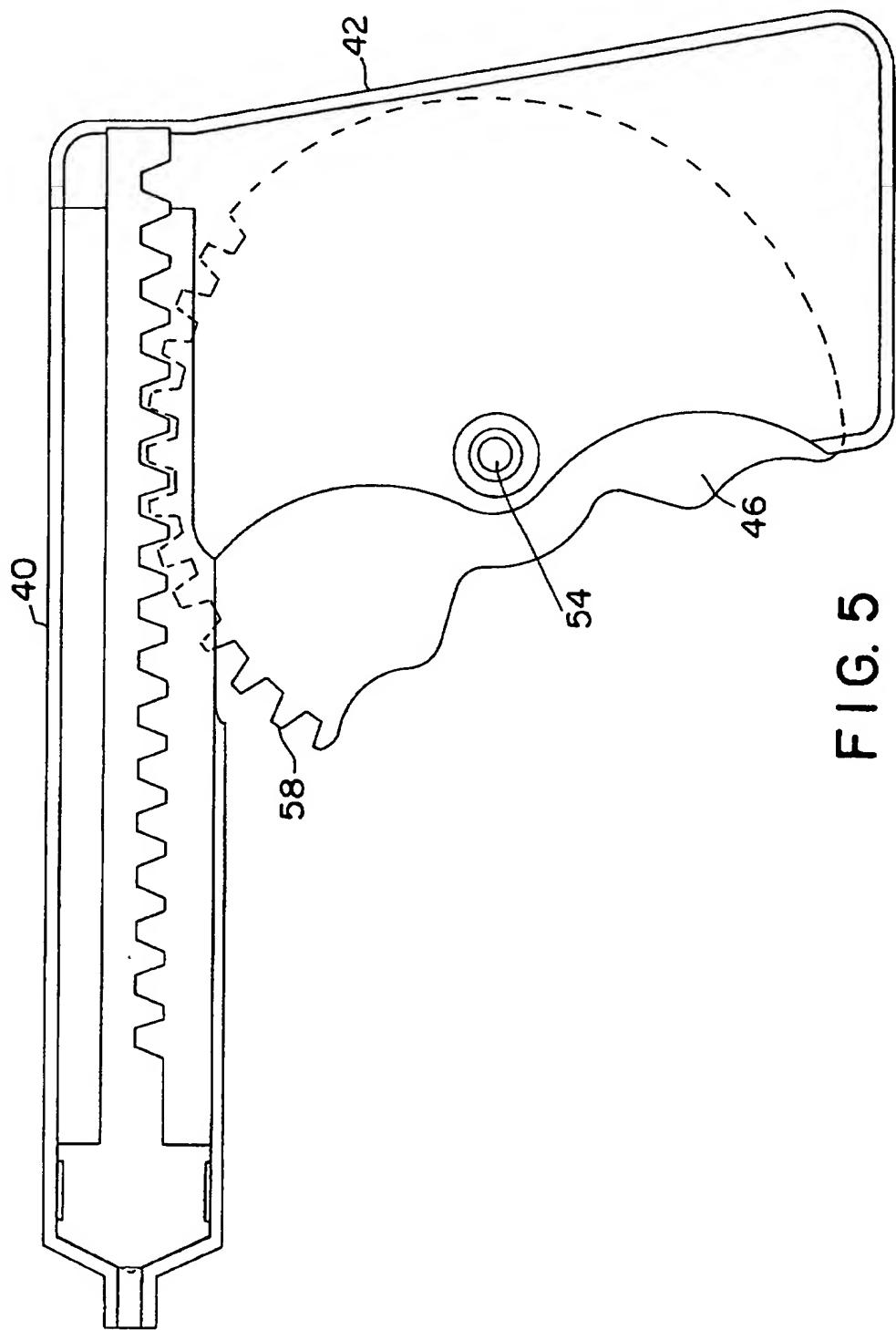


FIG. 4



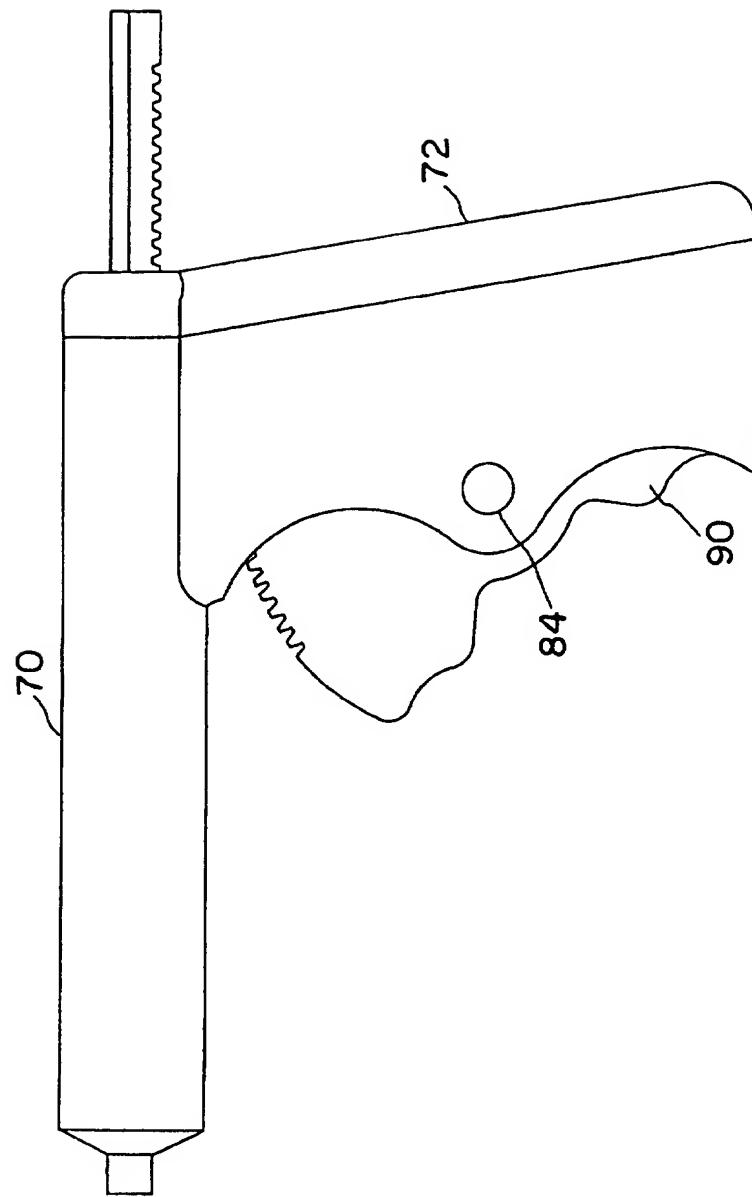


FIG. 6

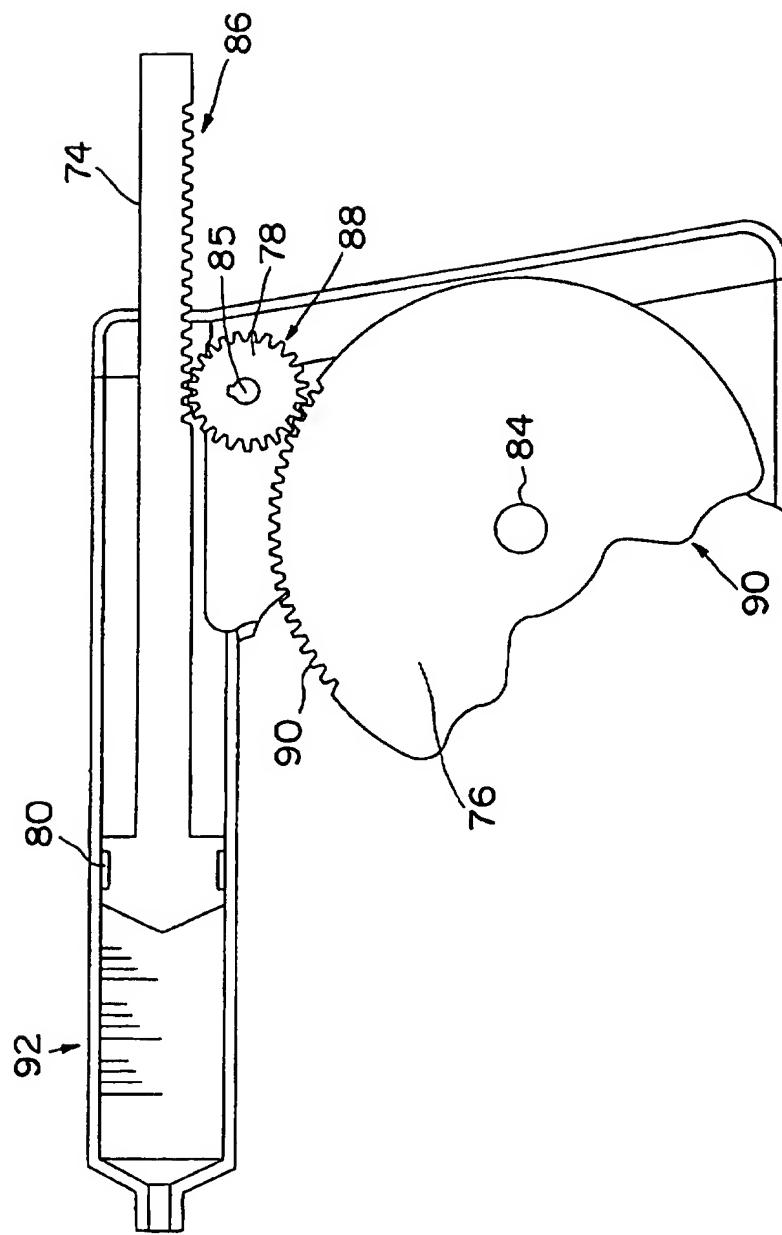


FIG. 7

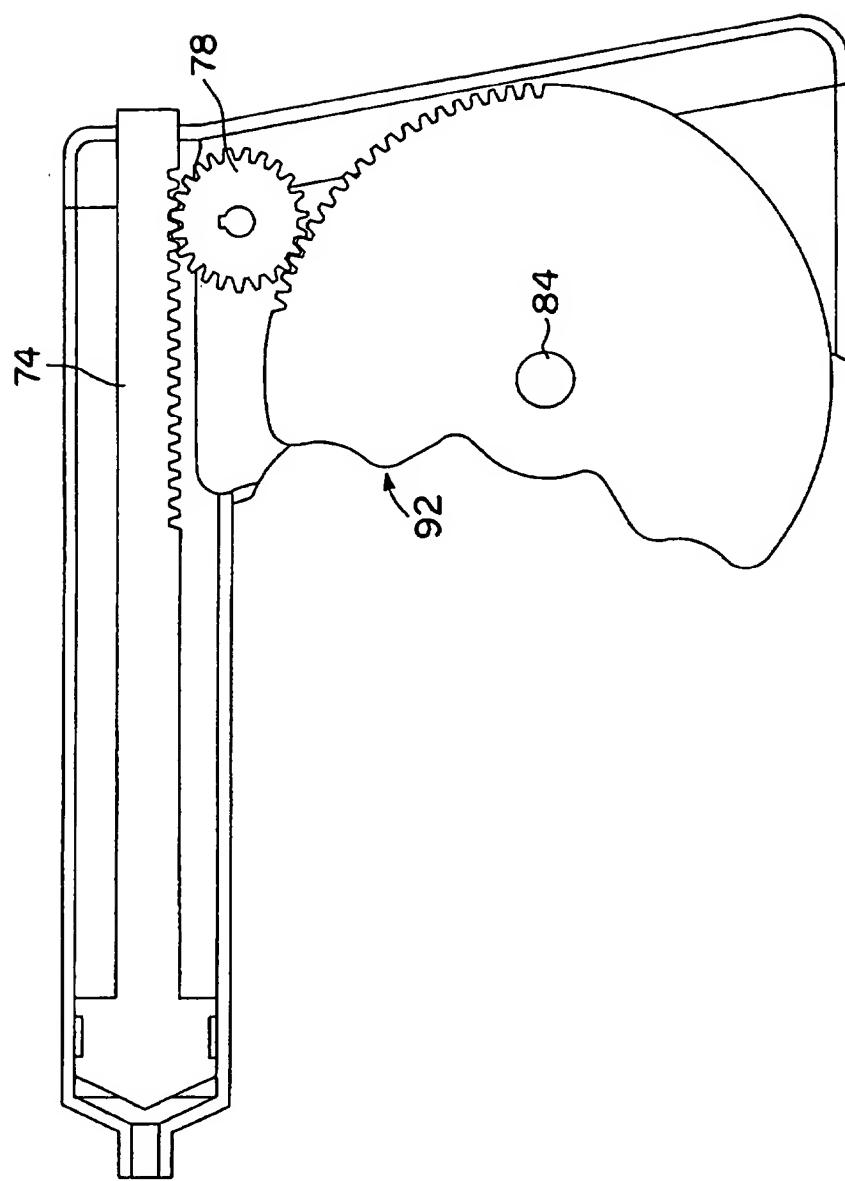


FIG. 8

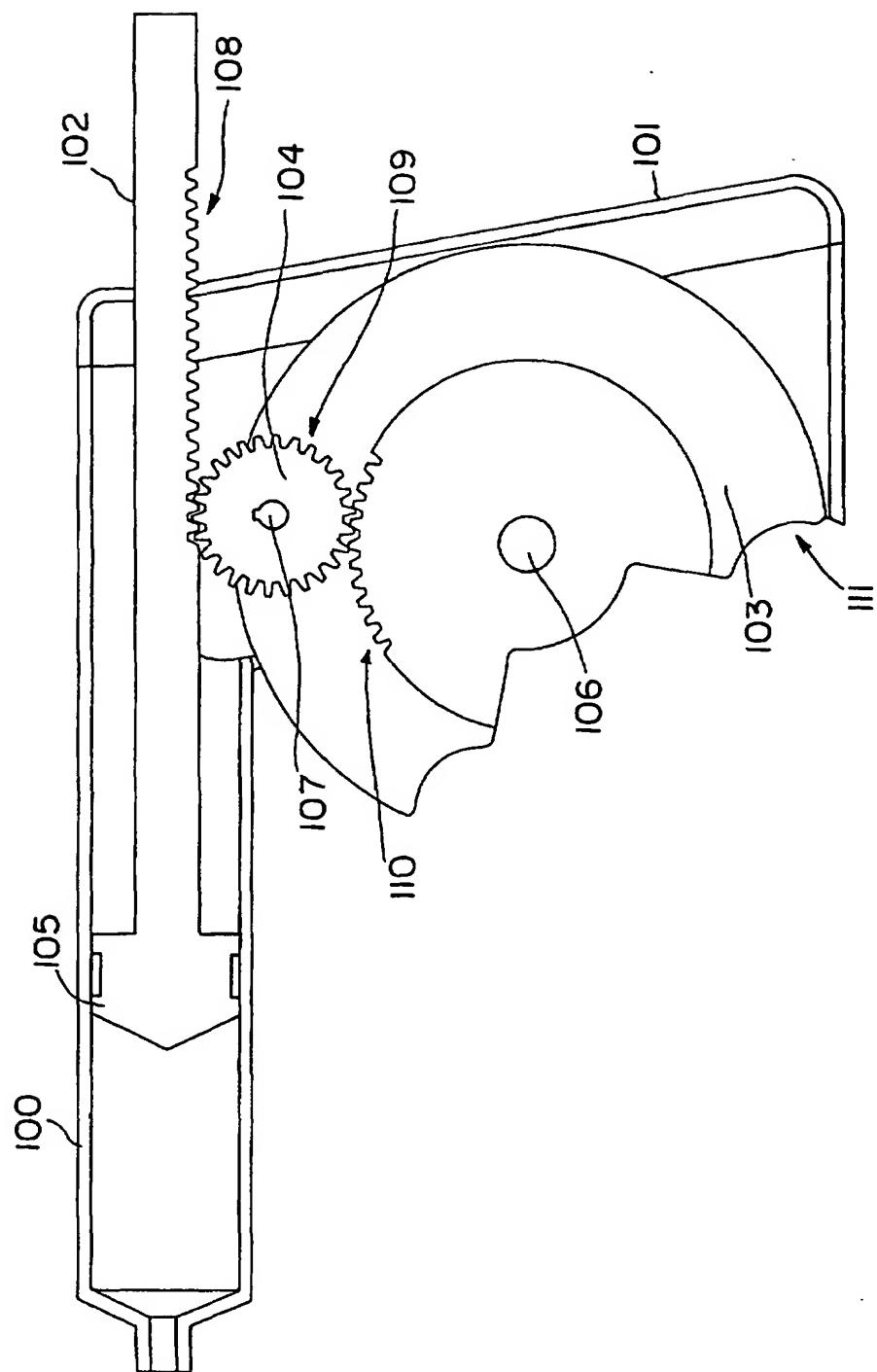


FIG. 9

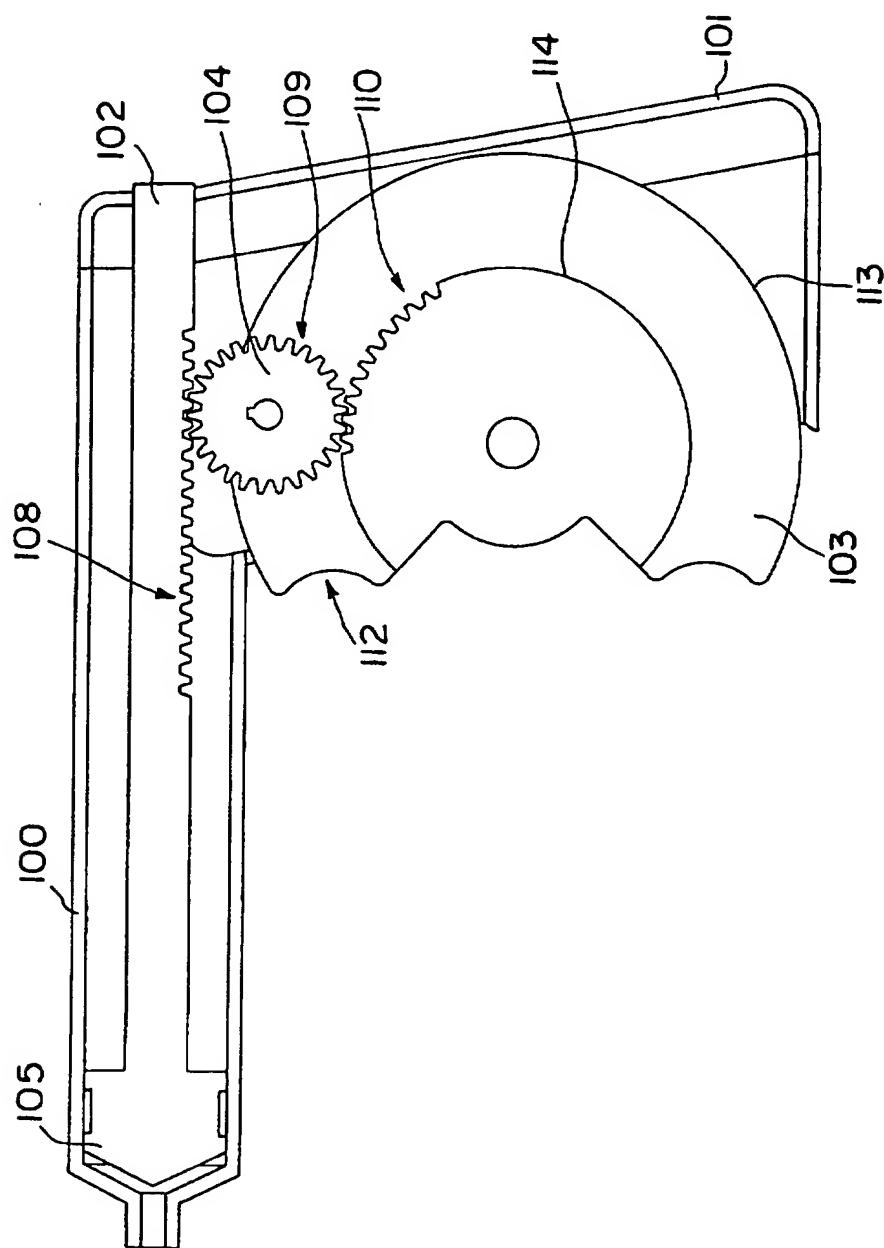


FIG. 10

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US00/05640

A. CLASSIFICATION OF SUBJECT MATTER

IPC(7) :A61M 5/00
US CL :604/187

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 604/187,

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

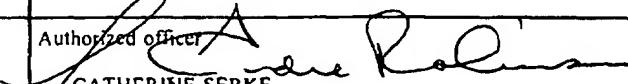
Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 5,865,811 A [DOYING, SR. et al.] 02 February 1999.	1-9
A	US 5,785,680 A [NIEZINK et al.] 28 July 1998, entire document.	1-9
A	US 5,078,690 A [RYAN] 07 January 1992, entire document.	1-9
A	US 4,968,303 A [CLARKE et al.] 06 November 1990, entire document.	1-9
A	US 4,883,101 A [STRONG] 28 November 1989, entire document.	1-9
A	US 4,014,331 A [HEAD] 29 March 1977, entire document.	1-9

Further documents are listed in the continuation of Box C. See patent family annex.

* Special categories of cited documents:	"T"	later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
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Date of the actual completion of the international search	Date of mailing of the international search report
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